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CONTENTS

	PAGE
SOLUTION OF HIGHER NUMERICAL EQUATIONS. <i>By A. H. Buchanan, LL.D., Dean of College and Professor of Mathematics in Cumberland University</i>	3
TEACHERS' CONFERENCE AND STUDENTS' DEBATE.	24
CUMBERLAND UNIVERSITY	
LOCATION	26
BUILDINGS	26
EQUIPMENT	27
DEPARTMENTS	28
REQUIREMENTS FOR ADMISSION	31
EXPENSES	32
ATHLETICS	32
MORAL TONE	36
LYCEUM	36
NEW CHAPEL	37
ALUMNI NOTES	38
FACULTY NOTES	46

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Knowledge does not comprise all which is contained in the large term education. The feelings are to be disciplined, the passions are to be restrained, true and worthy motives are to be inspired, a profound religious feeling is to be instilled, and pure morality inculcated under all circumstances. All this is comprised in education.

—Daniel Webster

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No. 1

SOLUTION OF HIGHER NUMERICAL EQUATIONS.

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Professor of Mathematics, Cumberland University.

For Freshman Class, Cumberland University.

ONLY the elements of "The Theory of Equations" necessary in the solution of higher numerical equations are given here.

ART. 1. The general form of a rational integral equation of any degree as the n th, with real coefficients, is

(1). $x^n + p_1 x^{n-1} + p_2 x^{n-2} + p_3 x^{n-3} + \dots + p_{n-1}x + p_n = 0$,
in which the coefficients $p_1, p_2, \dots, p_n$ are rational and n is a whole number. It is usually represented by $f(x)=0$, which is read the function of x equal to zero, and means any algebraic expression involving x in different powers with constant real coefficients.

On account of the difficulty of the proof it is assumed that every equation of the form $f(x)=0$ has one real root or two imaginary roots.

ART. 2. Any value of x which makes (1) equal to zero is called a root of that equation, and if such value is a_1 , then $x-a_1$ will divide it without any remainder.

Proof: Divide (1) by $x-a_1$ until the remainder R does not contain x , and call the quotient Q_1 , then

$$f(x) = (x-a_1) Q_1 + R.$$

Since a_1 is a root, $x-a_1=0$, or $x=a_1$, and hence $R=0$.

Again, if a_2 is a root also, (1) is divisible by $x-a_2$ and

$$f(x) = (x-a_1) (x-a_2) Q_2 = 0.$$

Likewise if $a_3, a_4 \dots a_n$ are roots, $x-a_3, x-a_4$, etc. will divide $f(x)=0$, until the last quotient Q_n not containing x will become equal to unity.

Hence $f(x)=(x-a_1)(x-a_2)(x-a_3) \dots (x-a_{n-1})(x-a_n)=0$, and therefore has n roots and no more—that is, as many as there are units in the highest exponent n .

In this investigation some or all the quantities a_1, a_2, a_3 , etc., may be equal, still there are n roots, though not all different.

ART. 3. To show the relation of the roots to the coefficients in equation,

$f(x)=x^n+p_1x^{n-1}+p_2x^{n-2}+p_3x^{n-3}+\dots+p_{n-1}x+p_n=0$,
suppose $a, b, c, d, \dots k$ to be the n roots, then

$$f(x)=(x-a)(x-b)(x-c) \dots (x-k)$$

gives by successive multiplications

$$(x-a)(x-b)=x^2+(a+b)x+ab,$$

$$(x-a)(x-b)(x-c)=x^3-(a+b+c)x^2+(ab+ac+bc)x-abc,$$

$$(x-a)(x-b)(x-c)(x-d)=x^4-(a+b+c+d)x^3+(ab+ac+ad+bc+bd+cd)x^2-(abc+abd+acd+bcd)x+abcd,$$

and so on to n factors, giving

$$x^n+p_1x^{n-1}+p_2x^{n-2}+p_3x^{n-3}+\dots+p_{n-1}x+p_n=x^n-(a+b+c+\dots+k)x^{n-1}+(ab+ac+ad+\dots+jk)x^{n-2}-(abc+abd+abe+\dots+ijk)x^{n-3}-abcdef\dots jk.$$

In this identity the following relations are evident:

$$-p_1=a+b+c+\dots+k,$$

$$p_2=ab+ac+ad+\dots+jk,$$

$$-p_3=abc+abd+\dots+ijk, \text{ etc. Or,}$$

1. The coefficient of the second term with its sign changed equals the sum of the roots.

2. The coefficient of the third term equals the sum of all the possible different products of the roots, taking two at a time.

3. The coefficient of the fourth term with its sign changed equals the sum of all the possible different products of the roots taken three at a time, and so on.

4. The last term equals the continued product of all the roots, the sign being + or - as n is even or odd.

From the above if the second term in $f(x)=0$ is wanting, the sum of the roots is zero; if the last term is wanting, at least one root is zero; and if the last term is an integer, it must be exactly divisible by every integral root.

ART. 4. Integral roots are easily obtained by synthetic division. Take this equation for illustration:

$$x^4 - 3x^3 - 21x^2 - 43x + 60 = 0$$

$$\begin{array}{r|l} 1 & -3 & -21 & +43 & +60 & 5 \\ & +5 & +10 & -55 & -60 & \end{array} \quad \text{Remainder zero.}$$

$$\begin{array}{r|l} 1 & +2 & -11 & -12 & 3 \\ & +3 & +15 & +12 & \end{array} \quad \text{Remainder zero.}$$

$$\begin{array}{r|l} 1 & +5 & +4 & -1 \\ & -1 & -4 & \end{array} \quad \text{Remainder zero.}$$

$$1 + 4.$$

The roots are 5, 3, -1 and -4, found as follows:

Place the detached coefficients as above and try 5, one of the factors of 60, multiply the 1 by it, and add to -3, giving +2, multiply +2 by 5 and add to -21, giving -11, multiply -11 by 5 and add to +43, giving -12, and finally multiplying -12 by 5 and adding to 60 gives zero, hence 5 is one root. Proceed in the same way with 3, -1, and -4. Thus the factors of the equation are found to be $x-5$, $x-3$, $x+4$, and $x+1$, which, placed equal to zero, give the roots as above. When a term in the equation is wanting, its place must be filled with a coefficient zero. When all but two of the roots have been found in this way, and these two are imaginary or incommensurable, they can be determined by solving the quadratic equation resulting from the elimination of the others.

The text-books give a very elegant method, based upon the calculus, for finding equal roots of an equation, but they may be found and eliminated as above before the necessary preparations for the method can be made.

Find the roots of the following, using only integral factors of the absolute terms:

1. $x^3+6x^2-6x-63=0$.
2. $x^4-15x^2+10x+24=0$.
3. $x^4+10ax^3+35a^2x^2+50a^3x+24a^4=0$.
4. $x^4+7x^3+9x^2-27x-54=0$.
5. $x^4-6x^3-28x^2+120x+288=0$.
6. $x^5-7x^3+2x^2+12x-8=0$.
7. $x^4-11x^3+44x^2-76x+48=0$ (equal roots).
8. $x^4+4x^3-18x^2-108x-135=0$ (equal roots).

The solution of these examples will familiarize one with the very simple method of determining the integral roots of any equation.

ART. 5. Formation of equations.

From the last article it is evident that if the roots of $f(x)=0$ are $a, b, c, \dots k$, it can be written

$$f(x)=(x-a)(x-b)(x-c)\dots(x-k)=0,$$

by subtracting each root from x , and placing the product of the resulting binomial factors equal to zero. Thus, to form the equation whose roots are 2, 5, and $-\frac{1}{2}$ by the rule

$$(x-2)(x-5)(x+\frac{1}{2})=0.$$

Whence,

$$x^3-6.5x^2+6.5x+5=0$$

EXAMPLES.

Find the equations whose roots are:

1. 1, 2, 3.
2. 0, 0, 2, 2, -3, -3.
3. $\frac{2}{3}, \frac{3}{2}, 1, -5$.
4. $-\frac{1}{2}, -\frac{2}{3}, -\frac{3}{4}, -\frac{4}{5}$.
5. $a+b, a-b, -a+b, -a-b$.
6. $2\pm\sqrt{3}, -2\pm\sqrt{3}$.

ART. 6. An equation whose coefficients are integers, that of the first term being unity, cannot have an irreducible rational fraction for a root, because such cannot be equal to a whole number.

ART. 7. Symmetrical functions of the roots, though seldom of any practical utility, may be easily determined. In the cubic

$$x^3 - px^2 + qx - r = 0,$$

suppose the roots are a, b, c , then $a + b + c = p$,

$$ab + ac + bc = q,$$

and $a^2 + b^2 + c^2 = (a + b + c)^2 - 2(ab + ac + bc) = p^2 - 2q$.

Substituting a, b, c in succession for x in the given equation and adding

$$a^3 + b^3 + c^3 - p(a^2 + b^2 + c^2) + q(a + b + c) - 3r = 0,$$

$$\text{or} \quad a^3 + b^3 + c^3 = p(p^2 - 2q) - pq + 3r,$$

$$\text{or} \quad a^3 + b^3 + c^3 = p^3 - 3pq + 3r.$$

Again, if a, b, c, d are the roots of

$$x^4 + px^3 + qx^2 + rx + s = 0,$$

$$\text{then} \quad a + b + c + d = -p,$$

$$ab + ac + ad + bc + bd + cd = q,$$

$$\text{and} \quad abc + abd + acd + bcd = -r.$$

From these find

$$-pq = a^2b + a^2c + a^2d + ab^2 + b^2c + b^2d + ac^2 + bc^2 + c^2d + ad^2 + bd^2 + cd^2 + 3(abc + abd + acd + bcd) = \text{sum of the squares of each into all the others} - 3r.$$

Hence the sum of the squares of each into all the others $= 3r - pq$.

IMAGINARY ROOTS.

ART. 8. In an equation with real coefficients imaginary roots occur in pairs. Suppose $f(x) = 0$ is an equation with real coefficients and that it has a root $a + b\sqrt{-1}$, then it will have another root, $a - b\sqrt{-1}$. That this may be true, $f(x) = 0$ must be divisible by $(x - a - b\sqrt{-1})(x - a + b\sqrt{-1}) = (x - a)^2 + b^2$. Let Q represent the resulting quotient, and $Rx + R^1$ the remainder, if any. Then

$$f(x) = Q[(x - a)^2 + b^2] + Rx + R^1 = 0.$$

In this equation $x = a + b\sqrt{-1}$ makes the term in brackets equal to zero, and since $f(x) = 0$ by hypothesis, it follows that

$$R(a + b\sqrt{-1}) + R^1 = 0.$$

From the principles of imaginaries and real quantities, as given in elementary algebra, the real and imaginary parts must be separately equal to zero; that is

$$Ra + R^1 = 0, \text{ and } Rb = 0.$$

But by hypothesis b is not zero, hence

$$R = 0 \text{ and } R^1 = 0,$$

and therefore $x = a - b\sqrt{-1}$ is also a root.

In the same way it may be proved that surd roots enter in pairs—that is, if $a + \sqrt{b}$ is a root, $a - \sqrt{b}$ will also be a root.

Solve by means of the above principles the following examples:

1. $3x^4 - 10x^3 + 4x^2 - x - 6 = 0$, one root being $\frac{1 + \sqrt{-3}}{2}$.
2. $x^4 - 36x^2 + 72x - 36 = 0$, one root being $3 - \sqrt{3}$.
3. $x^4 + 4x^3 + 5x^2 + 2x - 2 = 0$, one root being $-1 + \sqrt{-1}$.
4. $x^4 + 4x^3 + 6x^2 + 4x + 5 = 0$, one root being the $\sqrt{-1}$.
5. Form an equation of the fourth degree with rational coefficients one of whose roots is $\sqrt{2} + \sqrt{-3}$.

TRANSFORMATION OF EQUATIONS.

ART. 9. To transform an equation into another whose roots are those of the original with their signs changed.

In the given equation,

$$x^n + p_1x^{n-1} + p_2x^{n-2} + \dots + p_{n-1}x + p_n = 0,$$

put $-y$ for x , and the required equation becomes

$$y^n - p_1y^{n-1} + p_2y^{n-2} - \dots + (-1)^{n-1}p_{n-1}y + (-1)^np_n = 0.$$

Therefore the required transformation is obtained by changing the signs of the alternate terms in the given equation, beginning with the second. If any term of the given equation is missing, it must be supplied with zero as a coefficient. For example,

$$x^4 - 17x^2 - 20x - 6 = 0 \text{ should be written}$$

$$x^4 + 0x^3 - 17x^2 - 20x - 6 = 0,$$

then apply the rule

$$x^4 - 0x^3 - 17x^2 + 20x - 6 = 0, \text{ or } x^4 - 17x^2 + 20x - 6 = 0.$$

This transformation is useful in finding the negative roots of an equation, it being more convenient to use positive numbers in the method of synthetic division.

ART. 10. It is sometimes desirable to transform an equation with fractional coefficients into one in which they are all integral. To do this, substitute in $f(x)=0$, $\frac{y}{q}$ for x in

$$x^n + p_1x^{n-1} + p_2x^{n-2} + \dots + p_{n-1}x + p_n = 0, \text{ giving} \\ \left(\frac{y}{q}\right)^n + p_1\left(\frac{y}{q}\right)^{n-1} + p_2\left(\frac{y}{q}\right)^{n-2} + \dots + p_{n-1}\left(\frac{y}{q}\right) + p_n = 0,$$

which multiplied by q^n gives

$$y^n + p_1qy^{n-1} + p_2q^2y^{n-2} + \dots + p_{n-1}q^{n-1}y + q^n p_n = 0.$$

Hence this transformation may be made by multiplying second term by q , third by q^2 , fourth by q^3 , etc. Then give q the smallest value that will make all the coefficients integral. And when the values of y found in the resulting equation are divided by q , they will be the values of x in the original equation.

This transformation is never absolutely necessary.

ART. 11. To transform an equation into another whose roots shall be less by h than in the given equation.

Let $f(x) = x^n + p_1x^{n-1} + p_2x^{n-2} + \dots + p_{n-1}x + p_n = 0$, and substitute $x = y - h$, giving $f(x)$ the form

$$y^n + q_1y^{n-1} + q_2y^{n-2} + q_3y^{n-3} + \dots + q_{n-1}y + q_n = 0.$$

But $y = x - h$, and hence the following identity:

$$x^n + p_1x^{n-1} + p_2x^{n-2} + \dots + p_{n-1}x + p_n = (x-h)^n + q_1(x-h)^{n-1} + q_2(x-h)^{n-2} + \dots + q_{n-1}(x-h) + q_n.$$

Then the remainder, after dividing $f(x)$ by $x-h$, will be q_n and the quotient is

$$(x-h)^{n-1} + q_1(x-h)^{n-2} + \dots + q_{n-1}.$$

Dividing this remainder by $x-h$, the resulting remainder will be q_{n-1} , and the second quotient

$$(x-h)^{n-2} + q_1(x-h)^{n-3} + \dots + q_{n-2},$$

and so on. Thus $q_n, q_{n-1}, q_{n-2}, \dots$ are found by Horner's method of synthetic division, and when substituted in the

given equation the required equation results. This furnishes the method used in finding the numerical values of the incommensurable roots of an equation.

To illustrate this transformation take

$$2x^4 - x^3 - 2x^2 + 5x - 150 = 0$$

and let it be required to diminish the roots by 3,

$$\begin{array}{r}
 2-1-2+5-150 \quad | \quad 3 \\
 \hline
 +6+15+39+132 \\
 \hline
 +5+13+44-18 = q_4 \\
 \hline
 +6+33+138 \\
 \hline
 +11+46+182 = q_3 \\
 \hline
 +6+51 \\
 \hline
 +17+97 = q_2 \\
 \hline
 +6 \\
 \hline
 +23 = q_1
 \end{array}$$

Then the resulting equation is

$$2x'^4 + 23x'^3 + 97x'^2 + 182x' - 18 = 0.$$

Applications of this method will be given subsequently.

ART. 12. The preceding article also furnishes the means of obtaining from a given equation another with the second term wanting, by substituting for x , $x - \frac{q}{n}$. For illustration, take the equation

$$x^4 + 4x^3 + 2x^2 - 4x - 2 = 0,$$

and diminish the roots by $-\frac{q}{n} = -\frac{4}{4} = -1$.

$$\begin{array}{r}
 1+4+2-4-2 \quad | \quad -1 \\
 \hline
 -1-3+1+3 \\
 \hline
 +3-1-3 \quad | \quad +1 = q_4 \\
 \hline
 -1-2+3 \\
 \hline
 +2-3 \quad | \quad +0 = q_3 \\
 \hline
 -1-1 \\
 \hline
 +1 \quad | \quad -4 = q_2 \\
 \hline
 -1 \\
 \hline
 \quad | \quad -0 = q_1
 \end{array}$$

The resulting equation is $x'^4 + 4x'^2 + 1 = 0$.

Solving this and adding one to each of the roots, the roots of the given equation will result. It must not be inferred from this example that two of the terms will disappear; in general only one will do so.

RECIPROCAL EQUATIONS.

ART. 13. If an equation is unaltered by changing x into $\frac{1}{x}$, it is called a *reciprocal equation*.

Every equation of this class of an odd degree has a root $+1$ or -1 , and is therefore divisible by $x+1$ or $x-1$. Hence any reciprocal equation is of an even degree with its last term positive or can be reduced to that form.

A reciprocal equation of an even degree can be reduced to an equation of half its dimensions. Take the equation $ax^{2m} + bx^{2m-1} + cx^{2m-2} + \dots + kx^m + \dots + cx^2 + bx + a = 0$ and divide by x^m , giving

$$a\left(x^m + \frac{1}{x^m}\right) + b\left(x^{m-1} + \frac{1}{x^{m-1}}\right) + c\left(x^{m-2} + \frac{1}{x^{m-2}}\right) + \dots + k = 0.$$

Let $z = x + \frac{1}{x}$; then it is easily seen that

$$x^2 + \frac{1}{x^2} = z^2 - 2,$$

$$x^3 + \frac{1}{x^3} = z(z^2 - 2) - z = z^3 - 3z,$$

$$x^4 + \frac{1}{x^4} = (z^3 - 3z) - (z^2 - 2) = z^4 - 4z^2 + 2, \text{ etc.}$$

EXAMPLES.

1. $2x^4 + x^3 - 6x^2 + x + 2 = 0.$
2. $x^4 - 10x^3 + 26x^2 - 10x + 1 = 0.$
3. $x^5 - 5x^4 + 9x^3 - 9x^2 + 5x - 1 = 0.$
4. $4x^6 - 24x^5 + 57x^4 - 73x^3 + 57x^2 - 24x + 4 = 0.$

Note.—Divide 1 and 2 by x^2 , and solve as quadratics. Divide 3 by $x-1$, and solve as in 1 and 2. Reduce 4 to third degree, and solve.

LOCATION OF ROOTS.

ART. 14. Axiomatic Principles.

If all the coefficients of an equation are positive, it can have no positive roots.

If the coefficients of the even powers of x are all of one sign and the coefficients of the odd powers are all of the contrary sign, the equation can have no negative roots.

Every equation of an odd degree has at least one real root whose sign is opposite to that of its last term.

Every equation of an even degree having its last term negative has at least two roots, one positive and one negative.

ART. 15. A continuously varying quantity can change its sign only by passing through zero or infinity.

Hence, if by substituting in the equation $f(x)=0$ the quantities a and b for x and the resulting values $f(a)$ and $f(b)$ have contrary signs, then an odd number of roots will lie between a and b ; and if $f(a)$ and $f(b)$ have the same sign, either no root or an even number of roots will lie between a and b .

While a demonstration of these principles would perhaps be more scientific, it is possible for the reader to appreciate their truth by referring to the laws of coefficients, which is better.

ART. 16. *Sturm's Theorem.* This theorem is given in all text-books as the infallible means of finding the places of the roots of an equation, and from this fact and its noted scientific beauty, it may seem it should not be ignored. If, however, correct results can be secured without it, and with less work even than is necessary to determine the Sturman functions of a given equation, the student has the

right to be relieved of it. The only case perhaps where it is very necessary is when the roots are the same in several consecutive figures, as in Example 17, Art. 18, whose roots to three figures are 3.20 and 3.22, which rarely occurs and is more rarely of any value, and even in this case the roots are easily found without it.

CARDEN'S SOLUTION OF CUBIC EQUATIONS.

ART. 17. This is given, though it is of little practical utility, as it fails in the most important case—that is, when the roots are all real and unequal.

The general form of the cubic is:

$$x^3 + mx^2 + nx + p = 0.$$

By Art. 12, transform so as to eliminate the second term,

$$x^3 + qx + r = 0.$$

Let $x = y + z$, whence $x^3 = y^3 + z^3 + 3yz(y + z)$,

Substitution $y^3 + z^3 + (3yz + q)(y + z) + r = 0$,

in which $y + z$, being arbitrary, may be assumed so as to make

$$3yz + q = 0, \text{ whence } yz = -\frac{q}{3} \text{ and } z^3 = -\frac{q^3}{27y^3},$$

thus reducing the equation to

$$y^3 + z^3 = -r, \text{ or, substituting } z,$$

$$y^3 - \frac{q^3}{27y^3} = -r$$

$$y^6 + ry^3 = \frac{q^3}{27}$$

$$y = \sqrt[3]{-\frac{1}{2}r + \sqrt{\frac{r^2}{4} + \frac{q^3}{27}}}$$

$$z = \sqrt[3]{-\frac{1}{2}r - \sqrt{\frac{r^2}{4} + \frac{q^3}{27}}}$$

$$x = \sqrt[3]{-\frac{1}{2}r + \sqrt{\frac{r^2}{4} + \frac{q^3}{27}}} + \sqrt[3]{-\frac{1}{2}r - \sqrt{\frac{r^2}{4} + \frac{q^3}{27}}}$$

Example $x^3 - 15x - 126 = 0$.

$$x = \sqrt[3]{63 + \sqrt{(63)^2 + \left(-\frac{15}{3}\right)^3}} + \sqrt[3]{63 - \sqrt{(63)^2 + \left(-\frac{15}{3}\right)^3}}$$

or,

$$x = \sqrt[3]{125} + \sqrt[3]{1} = 6$$

Divide the given equation by $x - 6$, giving

$$x^2 + 6x + 21, \text{ whence } x = -3 \pm 2\sqrt{-3}$$

CUBIC EQUATIONS.

Incommensurable Roots.

ART. 18. The easiest and most simple method of solving the cubic having incommensurable roots is to determine one real root (Art. 14) by Horner's method, eliminate it by synthetic division, and then solve the resulting quadratic.

It is generally better, though not necessary, to make the coefficient of x^3 unity by division, giving the form

$$x^3 + mx^2 + nx + p = 0$$

If all the terms are positive or simply the last term is positive, the root will be negative, and in that case it is better to change the signs of the alternate terms so that the root in the resulting equation will be positive (Art. 9), but when it is determined it must be substituted in the given equation with the negative sign, of course.

The first figure of the root is found by trial (Art. 15)—that is, by finding two numbers differing by unity which substituted in the given equation will give results with contrary signs. Then diminish the roots of the given equation by the smaller number, using the method of synthetic division (Art. 11). Divide the last term in the transformed equation by the last term but one for the second figure of the root. Then diminish the roots of this first transformed equation by this second figure, which will result in the second transformed equation. Continue

this process until the requisite number of decimal places in the root has been obtained. The second figure of the root found in this way will often be too large for the same reason that the second figure in cube root is so, and it may be necessary to diminish it by more than one unit. It can always be found, however, by one or more trials.

The last two terms of the several transformed equations must be of contrary signs. In the first transformed equation this may not be the case, even when the first figure is correct; then the second figure will have to be found from the first transformed equation in the same way as the first figure was from the given equation. The same method must be used when the last term but one is zero in the transformed equation. The last two terms of the second transformed equation will always have contrary signs.

In this process sometimes the signs of the last two terms of the second transformed equation will be reversed from what they were in the original equation.

The coefficients of the successive transformed equations in the models of the solution are the successive numbers immediately below the broken lines.

After having found a number n of the figures of the root, $n-1$ more may be found by simply dividing the last term of the n th-1 transformed equation by its last term but one.

When a given number of decimals is required in the root, the work should be carried out to at least one more decimal place.

NOTE.—It is very necessary in the work of determining roots to be able to multiply and divide numbers by the contraction methods of higher arithmetic, by which a number of places in the product and quotient may be obtained without using the whole of the multiplier and multiplicand, or the whole of the dividend and divisor.

First example for illustration:

$$x^3 - 3x^2 - 2x + 5 = 0, \text{ root between 1 and 2.}$$

1-3	-2	+5	<u>1.201639</u>
<u>+1</u>	<u>-2</u>	<u>-4</u>	
-2	-4	+1	
<u>+1</u>	<u>-1</u>	<u>- .992</u>	
-1	-5	+ .008	
<u>+1</u>	<u>+ .04</u>	<u>- .004879399</u>	
-0	-4.96	+ .003120601	
<u>+ .2</u>	<u>+ .08</u>	<u>- .002927278</u>	
+ .2	-4.88	+ .000193323	
<u>+ .2</u>	<u>+ .000601</u>	<u>- .000146364</u>	
+ .4	-4.879399	+ .000046959	
<u>+ .2</u>	<u>+ .000602</u>	<u>- .000043909</u>	
+ .6	-4.878797 = (a)	+ .000003050	
<u>+ .001</u>			
+ .601			
<u>+ .001</u>			
+ .602			
<u>.001</u>			
+ .603			

By simple division dropping a figure from the right of (a) for each subsequent quotient figure,

Now remove this root from the given equation,

$$\begin{array}{r}
 1-3 \quad - \quad 2 \quad + \quad 5 \quad | \quad 1.201639 \\
 + 1.201639 - 2.160980 - 4.99999 \\
 \hline
 -1.798361 - 4.160980 + .000005 \text{ check}
 \end{array}$$

The resulting equation is, $x^2 - 1.798361x - 4.160981 = 0$

Whence, $x = .899181 \pm \sqrt{4.969506} = .899181 \pm 2.229239$

The roots are 1.201639, 3.128420, and -1.330058

Check: Sum = 3 to within one millionth.

SECOND EXAMPLE FOR ILLUSTRATION.

$$x^3 - 75x^2 - 5592.125x + 228415.649375 = 0,$$

1-75	-5592.125	+228415.649375	/32.7442075
+32	-1376.	-222980.	
-43	-6968.125	+ 5435.649375	
+32	- 352.	- 5113.4545	
-11	-7320.125	+ 322.194875	
+32	+ 15.19	- 291.533176	
+21	-7304.935	+ 30.661699	
+ .7	+ 15.68	- 29.149237216	
+21.7	-7289.255	+ 1.512461784	
+ .7	+ .9256	- 1.457443278	
+22.4	-7288.3294	+ .055018506	
+ .7	+ .9272	- .051010515	
+23.1	-7287.4022	+ .004007991	
+ .04	+ .092896	- .003643608	
+23.14	-7287.309304	+ .000364383	
+ .04	+ .092912		
+23.18	-7287.216392		
- .04			
+23.22			
+ .004			
+23.224			
+ .004			
+23.228			
+ .004			
+23.232			

one root between 32 and 33.

Now remove this root from the original equation,

1-75	-5592.125	+228415.649375	32.7442075
-32.7442075	-1383.6324377	-228415.649010	
-42.2557925	-6975.7574377	+ .000365	=check

The resulting equation is

$$x^2 - 42.2557925x - 6975.7574377 = 0$$

$$x = 21.1278962 \pm \sqrt{7422.1453497} = 21.1278962 \pm 86.1518742$$

Hence: Roots are

32.7442075, 107.2797704, and -65.0239780

Check: The sum of these is 75 to within one ten millionth.

The work would have been reduced nearly one-half if only four decimal places had been required.

If the root 107 in this example is obtained first, it will be found that the signs of the last two terms in the first transformed equation will be the reverse of those of the given equation, but will be obtained correctly notwithstanding; 108 gives a positive result, 107 a negative one, hence the root is between 107 and 108.

Solve the following examples (roots incommensurable):

1. $x^3 + 2x^2 - 23x - 70 = 0$
2. $x^3 - 3x^2 - 3x + 18 = 0$
3. $x^3 + 6x^2 + 10x - 1 = 0$
4. $x^3 - x^2 - 25x + 81 = 0$
5. $x^3 - 3x^2 - 4x + 13 = 0$
6. $2x^3 - 25x^2 + 56x - 147 = 0$
7. $x^3 - 15x^2 - 33x + 847 = 0$
8. $x^3 + 23x^2 + 13x + 13 = 0$
9. $x^3 + 23x^2 + 13x - 13 = 0$
10. $48x^3 - 96x^2 + 291x - 32 = 0$
11. $x^3 - 11 = 0$
12. $x^3 - 123x + 345 = 0$
13. $2x^3 + 3x - 4x - 10 = 0$
14. $x^3 + x - 1000 = 0$
15. $3x^3 + 5x - 40 = 0$
16. $x^3 - 315x^2 - 19684x + 2977260 = 0$
17. $x^3 + 11x^2 - 102x + 181 = 0$
18. $3x^3 - 1326x^2 + 6576x - 9177 = 0$

BIQUADRATIC EQUATIONS.

ART. 19. No better method of solving this class of equations has been found than that first discovered by Ferrari. If the roots are all real, they may be found by

Horner's method, but they may all be imaginary, and his formula enables the solution to be made in that case, and therefore in all cases without the use of Sturm's or Fourier's theorems for real roots. Hence only this is given here.

FERRARI'S FORMULA.

ART. 20. Take the general form of the biquadratic

$$(1) \quad x^4 + mx^3 + nx^2 + px + q = 0$$

This is to be resolved into quadratic equations of the form

$$x^2 + ax + y = 0$$

$$x^2 + bx + z = 0$$

The product of these is

$$(2) \quad x^4 + (a+b)x^3 + (ab+y+z)x^2 + (az+by)x + yz = 0$$

By comparison with (1) above

$$(3) \quad a+b=m$$

$$(4) \quad ab+y+z=n$$

$$(5) \quad az+by=p \text{ and}$$

$$(6) \quad yz=q$$

Transpose (4) $ab=n-y-x$, square (3) and subtract
 $4ab=4n-4(y+z)$ and reducing

$$a-b=\sqrt{m^2-4n+4(y+z)}$$

$$(7) \quad \text{Whence } a=\frac{1}{2}m+\frac{1}{2}\sqrt{m^2-4n+4(y+z)}$$

$$(8) \quad b=\frac{1}{2}m-\frac{1}{2}\sqrt{m^2-4n+4(y+z)}$$

Multiply (7) by z and (8) by y , add and compare with (5)

$$2p=m(y+z)+(z-y)\sqrt{m^2-4n+4(y+z)}$$

Transpose, solve for $z-y$, square, and add four times (6)

$$(z+y)^2 = \frac{4p^2 - 4m(y+z) + m^2(y+z)^2}{m^2 - 4n + 4(y+z)}$$

Put $z+y=A$, clear of fractions, transpose and divide by 4

$$(9) \quad A^3 - nA^2 + (mp - 4q)A - p^2 - m^2q + 4nq = 0$$

This is Ferrari's formula. It will always have one real root, and may have three; in the latter case it is easily decided which root must be taken, since this relation must exist when A is positive, $A \geq 2\sqrt{q}$ numerically; but when

q is negative any one of the three roots of A will give the same results.

Then, $z-y = \frac{2p-mA}{\sqrt{m^2-4n+4A}}$, whence y and z are found.

Also, $a = \frac{1}{2}m + \frac{1}{2}\sqrt{m^2-4n+4A}$
and $b = \frac{1}{2}m - \frac{1}{2}\sqrt{m^2-4n+4A}$

Check then by $(1+a+y)(1+b+z) = 1+m+n+p+q$, which is self-evident. Substituting these in the two assumed quadratics and solving, the four roots are found from them, whether real or imaginary.

EXAMPLE FOR ILLUSTRATION.

$$x^4 - 2x^3 - 5x^2 + 10x - 3 = 0$$

By Ferrari's Formula:

$$\begin{array}{r} A^3 + 5A^2 - 8A - 28 = 0 \\ 1 \quad +5 \quad -8 \quad -28 \quad | \quad -2 \\ \quad \quad -2 \quad -6 \quad +28 \quad \underline{\hspace{1cm}} \\ 1 \quad +3 \quad -14 \quad -00 \end{array}$$

Hence, $A^2 + 3A - 14 = 0$

$$A = -\frac{3}{2} \pm \frac{1}{2}\sqrt{65} \text{ or } 2.53112888, -5.53112888$$

In this example, q being negative, any one of the three values of A will give exactly the same solution. The first will require less work, and hence is taken.

Substituting in the given formula,

$$z-y = \frac{20-4}{\sqrt{4+20-8}} = 4$$

$z+y = -2$, whence $z=1$ and $y=-3$,

$a = -1+2=1$, $b = -1-2=-3$

Check, $(1+1-3)(1-3+1) = 1-2-5+10-3=1$

Hence, $x^2+x-3=0$; whence, $x = -\frac{1}{2} \pm \frac{1}{2}\sqrt{13}$

Hence, $x^2-3x+1=0$; whence, $x = 1\frac{1}{2} \pm \frac{1}{2}\sqrt{5}$

SECOND EXAMPLE FOR ILLUSTRATION.

$$x^4 + 13x^3 + 75x^2 + 219.375x + 2111 = 0$$

Ferrari's formula gives

$$A^3 - 75A^2 - 5592.125A + 228415.649375 = 0$$

This is the same as the second example solved in cubics (see p. 17), where its roots are given, 32.7442075, 107.-2797704, and -65.0239780. Only one of these roots, 107.-2797704, meets the requisition $>2\sqrt{2111}$

hence, $z+y=107.2797704$

By formula (10)

$$z-y = \frac{438.75-1394.637015}{\sqrt{169-300+429.1190816}} = -\frac{955.887025}{17.266125} = -55.36202$$

$$y=81.320895$$

$$z=25.95888$$

$$a=6.5+8.633062=15.133062$$

$$b=6.5-8.633062=-2.133062$$

Check, $(1+15.133062+81.320895)(1-2.133062+25.95888)$ equal to $1+13+75+219.375+2111=2419.3742$, should be 2419.375, due to error in not carrying the decimals farther.

The resulting quadratic equations are

$$x^2+15.13306x+81.320895=0$$

$$x^2-2.13306x+25.95888=0$$

Hence, $x=-7.56653 \pm \sqrt{-24.06850}$

and, $x=1.06653 \pm \sqrt{-24.82151}$

In this example, though all the roots are imaginary, there is no more difficulty in finding them than if all were real.

EXAMPLES OF BIQUADRATIC EQUATIONS.

With Incommensurable Roots.

$$1. x^4-2x^2+8x-3=0$$

$$2. x^4-14x^3+59x^2-60x-36=0$$

$$3. x^4+x^3+x^2+3x-100=0$$

$$4. 5x^4-27x^3-102x^2+166x+250=0$$

$$5. x^4-80x^3+1998x^2-14937x+5000=0$$

$$6. x^4-6x^3+12x^2-14x+3=0$$

$$7. 5x^4+28x^3+51x^2+32x-1=0$$

$$8. x^4-5x^3+37x^2-3x+39=0$$

$$9. 6x^4-29x^3+40x^2-7x-12=0$$

10. $3x^4 - 10x^3 + 4x^2 - x - 6 = 0$
11. $6x^4 - 13x^3 - 35x^2 - x + 3 = 0$
12. $x^4 + 4x^3 + 5x^2 + 2x - 2 = 0$
13. $4x^4 - 4x^3 - 7x^2 - 4x + 4 = 0$
14. $x^4 - 8x^3 + 20x^2 - 15x + \frac{1}{2} = 0$
15. $x^4 - 5x^3 + 3x^2 + 35x - 70 = 0$
16. $x^4 - 21x^3 + 166x^2 - 546x + 580 = 0$

EQUATIONS OF FIFTH DEGREE.

ART. 21. The quintic being of an odd order, one real root can always be found by Horner's rule, which, when divided out, gives an equation of the fourth degree. Then this may be solved as in Art. 20. Therefore nothing additional is required in this case.

QUINTIC EXAMPLES.

1. $x^5 - x^4 + 8x^2 - 9x - 15 = 0$
2. $x^5 + 4x^4 - 3x^3 + 10x^2 - 2x - 962 = 0$
3. $x^5 - 1 = 0$
4. $x^5 + 5x^4 + x^3 - 16x^2 - 20x - 16 = 0$
5. $x^5 - 5x^4 + 9x^3 - 9x^2 + 5x - 1 = 0$
6. $x^5 - 4x^4 + 7x^3 - 863 = 0$
7. $x^5 + 14x^4 + 43x^3 - 48x^2 - 258x - 72 = 0$

BICUBIC EQUATIONS.

ART. 22. The best mathematicians admit the impossibility of the algebraic solution of the general equation of a higher degree than the fourth. The solution of the fourth degree depends upon that of the third, so also the solutions of the fifth and sixth degrees depend upon the resolution of these into cubic or quadratic equations. Until the general problem for the higher degrees has been solved for the general case they cannot be resolved into the lower degrees, and therefore cannot be solved.

When the higher degrees have coefficients sustaining

certain known relations, they may often be solved. It is sometimes announced that "the impossible has been done;" in all cases as yet they have proven miserable failures. One has recently appeared in the form of a pretentious volume that falls to the ground under a single query. As in this instance, these so-called solutions depend upon some interrelation of coefficients or roots that may not occur once in a hundred examples. For instance, when the sum of three roots of an equation of the fifth degree is equal to the sum of the other two it can be resolved into a cubic and a quadratic. When the sum of three roots of one of the sixth degree is equal to the sum of the other three it can be resolved into two cubics. In both these cases complete solutions can be made; but why parade them in a text-book when perhaps such relations will not occur once in a thousand examples?

Therefore only such examples of the sixth degree are given here as have two real roots, and such of the seventh as have three; which can be removed in either case by Horner's rule, and the resulting fourth-degree equation can then be solved.

BICUBIC EXAMPLES.

1. $x^6 - 10x^5 + 22x^4 + 11x^3 - 50x^2 - 164x - 96 = 0$
2. $x^6 - 6x^5 + 9x^4 - 16x^2 - 40x - 25 = 0$
3. $x^6 - 38x^4 - 40x^3 + 217x^2 + 160x - 215 = 0$
4. $x^6 - 12x^5 + 9x^4 + 109x^3 - 34x^2 - 267x - 26 = 0$
5. $x^6 - 3x^5 + 3x^4 - 78x^3 + 165x^2 - 165x + 1256 = 0$
6. $x^6 - 19x^4 - 22x^3 + 84x^2 + 179x + 85 = 0$
7. $x^7 + x^6 - 20x^5 + x^4 + 48x^3 + 76x^2 - 24x - 28 = 0$

INTERSCHOLASTIC TEACHERS' CONFERENCE AND STUDENTS' DEBATE.

THE little more than one year in which David E. Mitchell has been President of Cumberland University has been pregnant with good things for the institution and the cause of higher education in the South. The University endowment has been very considerably increased; the already creditable equipment greatly improved; faculties enlarged, two new departments added; a magnificent new dormitory erected; the student attendance greatly increased, and more than twenty high-grade preparatory schools articulated with the University, while a number of other preparatory schools have been rendered very friendly, placing Cumberland University on at least an equal footing with other universities. But no single event of the past year is destined to do more in the future for the cause of Christian education in general than the successful launching of an Interscholastic Teachers' Conference and Students' Debate, the first annual meeting of which was held in Cumberland University Chapel on November 25, 1903. The following programme was followed:

Invocation.

Permanent Organization.

Bible Study in Secondary Schools. N. J. Finney, Cookeville, Tenn.

Address. Dr. R. G. Pearson, Lebanon, Tenn.

English Methods. M. M. Summar, Lewisburg, Tenn.; Charles E. Bates, Auburn, Ky.

The Cigarette Problem. A. J. Brandon, Tullahoma, Tenn.; L. L. Rice, Lebanon, Tenn.

Is Physical Punishment Essential in the Discipline of Secondary Schools? William R. Webb, Bellbuckle, Tenn.; O. N. Smith, Lebanon, Tenn.

The Conference lasted from 11 A.M. to 4:30 P.M. Many of the best preparatory schools of the South were repre-

sented, and many prominent schoolmen, in addition to those on the programme, took part in the general discussions. Prof. A. J. Brandon, of Tullahoma, was elected Permanent Chairman, and Prof. L. L. Rice, of Lebanon, Tenn., Secretary.

From five to eight o'clock a magnificent banquet was served in the new dormitory dining hall, complimentary to the occasion. More than seventy-five teachers, student representatives, and other friends of the University were present.

In the evening, beginning at eight o'clock, was held a debate between student representatives of preparatory schools. The question discussed was: "*Resolved*, That the colonial policy of the United States is unwise."

Speakers for the affirmative were:

Derward Sperry, Caldwell Training School, Mt. Juliet, Tenn.

E. B. Arnold, Brandon Training School, Tullahoma, Tenn.

Eliot James, Male and Female Academy, Providence, Ky.

Will Montgomery, Haynes-McLean School, Lewisburg, Tenn.

Speakers for the negative:

George Lewis, Bethel College, McKenzie, Tenn.

Charles Cox, Castle Heights, Lebanon, Tenn.

William T. Salmon, Auburn Seminary, Auburn, Ky.

Sickness prevented several other schools from being represented. The young men all acquitted themselves in a most creditable manner, and the enthusiasm so characteristic of college boys was shown. The gold medal was awarded Charles Cox, of Castle Heights, and honorable mention was made of William T. Salmon, of Auburn, Ky., as making the second honor. The judges were Rev. James E. Clark, the newly elected editor of the *Cumberland Pres-*

byterian, John H. DeWitt, of Nashville, Tenn., and Judge R. P. McClain, of Lebanon, Tenn.

The Teachers' Conference and Students' Debate will be held annually in the Chapel of Cumberland University, and will be looked forward to with much interest as an event of more than ordinary interest in school life. The railroads generously grant reduced rates, and entertainment to teachers and student representatives is furnished by the University.

CUMBERLAND UNIVERSITY.

FOR more than half a century Cumberland University has occupied a prominent place in the higher education of the South.

LOCATION.

Cumberland University is located at Lebanon, Tenn., thirty miles east of Nashville. Lebanon is a beautiful little town of the highest culture and refinement. Railroad facilities are the very best. Between Lebanon and Nashville we have fourteen trains daily, and between Lebanon and Knoxville four daily. Our location gives us all the advantages of a small town in moderate expense and minimum of temptation; while our proximity to Nashville and very splendid railroad facilities give us all the advantages of the city.

BUILDINGS.

The buildings are large and commodious. Memorial Hall, the main building of the University, is occupied by the Literary, Engineering, and Theological Schools and School of Oratory. It is situated on a beautiful elevation and in the center of a beautiful campus of fifty acres. This building contains more than fifty rooms, especially designed and adapted for college and university work.

Caruthers Hall, the gift of Gov. Robert L. Caruthers, situated on West Main Street, contains the law lecture rooms, the general repository and law library, and a large auditorium for the general meetings for students and for the University exercises.

Divinity Hall, situated on West Main Street, and once the home of the Theological School, has been thoroughly renovated, and is now used as the University dormitory and refectory.

The new dormitory, situated on the Campus of the University, is a most magnificent building. It was erected at an expense of \$50,000, and is furnished with every modern convenience. It accommodates about one hundred students. Several members of the faculty have suites in the building. The dormitory is found to fill a long-felt want among the student body for some centralized home on the campus and within easy reach of the main building, libraries, laboratories, and gymnasium.

Castle Heights, the best-equipped boys' school in the South, and articulated with the University as a Training School, is situated on West Main Street, one mile from the Public Square.

The Lebanon College for Young Ladies is a large three story stone-and-brick structure, situated on North Cumberland Street. The building has been enlarged and remodeled throughout, and is thoroughly modern in convenience.

EQUIPMENT.

1. *Libraries.* The equipment of the University is first-class, consisting of libraries (general and departmental), laboratories (chemical, physical, biological), and a museum of natural history.

The Hale Reference Library was established for the exclusive use of the Theological Department, through the liberality of Mrs. E. J. Hale, of Morristown, Tenn., in

memory of her husband, Dr. E. B. Hale, recently deceased.

The Mitchell Library, most elegantly furnished with cabinet mantel, sectional bookcases, and other furniture to match, is the gift of President David E. Mitchell to the Academic Department. It occupies a room on the first floor of Memorial Hall. It is especially adapted to the work of students in the Academic Department.

The Law Library has been recently established by the Board of Trustees. It already contains several thousand volumes, and occupies a room in Caruthers Hall, where is found also the General Repository.

These libraries contain over twenty thousand volumes.

2. *Laboratories.* The Chemical Department has at its command a number of rooms in the University building, being modern in equipment. In addition to the general lecture room, there are laboratories for general and analytic work, well-equipped desks and apparatus for students, ample enough for the courses offered. A gift of \$2,500 has been made recently to the Chemical Laboratory.

The Department of Physics has at its command a suite of rooms on the first floor of the University building. This department has apparatus worth many hundreds of dollars, and, as the other laboratories, is adding to its stock every year.

Biological Laboratory. It is with very great pleasure that the University announces the acquisition of a thoroughly first-class Biological Laboratory. It is the gift of Mr. Frank W. Nisbet, of St. Louis, Mo. It will be supplied with all the apparatus required in a college laboratory, and will occupy rooms on the second floor of Memorial Hall.

DEPARTMENTS.

Theological Department. The faculty consists of nine professors and instructors. Special courses in English

Bible study and evangelistic work are given, also careful training in oratory. Special courses of lectures on Sunday school methods. Exceptional opportunities for training in vocal music.

Our Theological School is the third largest among Presbyterians in the United States. Princeton leads, McCormick is second, and Cumberland University is third.

Among the special advantages of this department are a well-balanced course of instruction, framed with reference to the needs of the denomination it serves; a situation easily accessible from most parts of the Church, and a territory close at hand affording abundant and varied opportunity for work by the student as missionary, supply, or occasional preacher.

Engineering School. The faculty consists of six specialists. A four years' course leads to the degree of Civil Engineer.

The course of instruction in this school embraces the following:

1. Civil Engineering.
2. Mining Engineering.
3. Architecture and Design.
4. Geodesy and Topography.

A very thorough course is given. Prof. Buchanan, dean of this department, is a man of national reputation as a mathematician, having been connected for twenty years with the United States Coast and Geodetic Service.

We have perfected arrangements with one of the best technical schools of the North, in accordance with which they will take all our graduates of this department and give them employment in the line they have chosen, paying them wages for their work, thus giving unusual opportunities to such young men to more thoroughly prepare themselves by actual experience for their life's work.

College Department. Faculty consists of ten members.

Four years' courses lead to the degrees of B.S. and A.B. Graduate courses lead to the degrees of A.M. and Ph.D.

No university in the South has a higher standard for admission. Written examinations are required where certificates from accredited schools are not presented. However, we offer special accommodations to students prepared for college in most of their studies, but deficient in a few things. A student can enter the University conditioned on anything which he can make up in Castle Heights while the regular college work is being done. This involves no extra expense.

Law School. Courses leading to the degrees of LL.B. and LL.M. The course leading to LL.B. is completed in one year.

This department has been an acknowledged success for nearly sixty years. The course of study is equal to the two years' course in any other law school. It covers more than ten thousand pages of American law. The best textbooks of the most famous authors only are used. These books are actually read by the student of the school under the immediate direction of the faculty. There are daily recitations and moot courts. Graduates from this school are thoroughly prepared for practice.

School of Oratory. Faculty consists of seven instructors. A three years' course leads to the degree of Bachelor of Oratory. The sixteen courses of instruction offered here afford a training for breadth, thoroughness, and artistic finish which is not excelled by the best professional schools of the East. This school gives the student a thorough preparation for the public professions, as well as developing his art as an orator.

Conservatory of Music. Faculty consists of ten instructors. A score of special lectures and entertainments for the first year have been provided.

A four years' course is planned, leading to the degree of

Bachelor of Music, and including thorough work in harmony, playing, theory, history, etc. The director, Herr Eugene Feuchtinger, of Hiram, O., is known as one of the most successful German-American music teachers of this country. Credit for Conservatory work will be given in the University. The most modern and improved methods will be followed, as the Leschetitzsky for piano, the Italian for voice, and the Mason and Vergil methods where applicable. No better and cheaper advantages are possible for the most thorough musical education. The opening of the first year's work has been most flattering.

ADMISSION.

Women are admitted to all classes on the same footing with men. Requirements:

1. *English.* Preparation for admission to the English work includes a thorough training in grammar, English composition, spelling, punctuation, and capitalization. The contents of the following books must be mastered: Shakespeare's "Merchant of Venice" and "Julius Cæsar," the "Sir Roger de Coverley Papers," Goldsmith's "Vicar of Wakefield," Coleridge's "Ancient Mariner," Scott's "Ivanhoe," Carlyle's "Essay on Burns," Tennyson's "Princess," Lowell's "Vision of Sir Launfal," George Eliot's "Silas Marner." For special study and practice: Shakespeare's "Macbeth," Milton's "L' Allegro," "Il Penseroso," "Comus," and "Lycidas," Macaulay's "Milton" and "Addison," and Burke's "Conciliation with the Colonies."

2. *Mathematics.* Candidates for entrance should have completed arithmetic, algebra through quadratic equations, plane and solid geometry, and be familiar with the metric system of weights and measures, and be able to use logarithmic tables.

3. *Science.* They should have a fair knowledge of geog-

raphy and physiography, elementary physics, anatomy, physiology, and hygiene.

4. *Latin*. Required: Cæsar (four books) or equivalent, Cicero's Oration against Catiline, the Citizenship of Archias, and one other oration left to the choice of the teacher; Virgil's *Æneid* (six books); sight translation in Viri Romæ, Cæsar, and Nepos; prose composition.

5. *Greek*. Xenophon's *Anabasis* (four books), Homer's *Iliad* (three books), and prose composition. Modern languages may be substituted for Greek.

6. *Modern Language*. One year in modern language will be required.

EXPENSES.

Tuition, Academic and Oratory, per term.....	\$25 00
Tuition, Law and Engineering, per term.....	50 00
Contingent Fee, Academic, Engineering, Oratory, per term.....	10 00
Contingent Fee, Law and Theology, per term.....	6 00
Diploma Fee for Graduates.....	5 00
Expenses for Conservatory of Music and Graduate Courses on application.	
Board, Divinity Hall, per month.....	10 00
Board, New Dormitory, per month.....	\$13 00 to 15 00
Board in families, per month.....	\$13 00 to 16 00

ATHLETICS.

Believing that athletics is an essential feature of college and university life, the members of the Faculty coöperate with the student body in the effort to promote a healthy athletic spirit, and to maintain the standing of the University in the annual intercollegiate contests.

FOOTBALL.

Cumberland's Record for 1903.

Cumberland.....	6	Vanderbilt.....	0
Cumberland.....	0	Sewanee.....	6
Cumberland.....	86	Tennessee Medical College..	0
Cumberland.....	92	Grant University.....	0
Cumberland.....	44	University of Alabama.....	0
Cumberland.....	41	Louisiana State University..	0
Cumberland.....	28	Tulane University.....	0
Cumberland.....	11	Clemson College.....	11
Total.....	308	Total.....	17

Above stands the unparalleled record of Cumberland University's football team for 1903. In eight games she has piled up the enormous score of 308 points in her favor to 17 against her. No team in the S. I. A. A. ever scored so many points in a single season except Sewanee, but she played twelve games some years ago to do it. Cumberland's is the greatest record ever made in eight games. While Cumberland has piled up this enormous score, the other three of the S. I. A. A.'s Big Four scored: Vanderbilt, in eight games, 192 to 16; Sewanee, in eight games, 179 to 10; Clemson, in seven games, 171 to 22.

Cumberland did the unusual: she began her work with hard games, meeting Vanderbilt first and Sewanee second. These were great games. In another respect her schedule was remarkable. On her Southern trip she played three games in six days. Only one week later she played her final and hardest game with Clemson. One-half of Cumberland's whole schedule was played in the last twelve days of the season. This Southern trip, defeating the University of Alabama 44 to 0, Louisiana State University 41 to 0, and Tulane 28 to 0, and traveling fifteen hundred miles, all in six days, was possibly the greatest record for one trip ever made by any team. The game with Tulane might have been won by a much larger score but for the fact that six subs were used in order to preserve as much as possible the team for the final game on Thanksgiving. The game with Clemson was the hardest game of the season. Cumberland's men were in very bad condition. The terrible strain and consequent exhaustion of the Southern trip told heavily on the team, especially in the last half. One member of the team was really quit ill with tonsilitis, and four or five others were so badly bruised that they could not do their best work. Several members of the team had been unable to practice since the Southern trip. Clemson's is a great team; and had Van-

derbilt and Sewanee played her, the relative strengths of the Big Four might have been quite different from what it now appears.

Cumberland's record is certainly great. The Big Four all had their goal line crossed. Cumberland suffers not in comparison here. Had Sewanee defeated Vanderbilt, she might have claimed the championship; but she lost, and lost before a team which Cumberland had defeated. It is true that Sewanee defeated Cumberland by a score of 6 to 0, but that fact is more than counterbalanced by the two games which Cumberland played against teams that Sewanee had played, defeating them by scores almost double that of Sewanee. Sewanee, in fifty minutes, scored only 23 to 0 against the University of Alabama; while Cumberland, in thirty-five minutes, piled up a score of 44 to 0. Sewanee, in forty-five minutes, scored only 52 to 0 against the Tennessee Meds; while Cumberland, in thirty-five minutes, scored 86 to 0.

Cumberland defeated Vanderbilt by a score of 6 to 0, and also scored, in thirty-five minutes, 44 to 0 against the University of Alabama; while Vanderbilt, in fifty minutes, could score only 30 to 0 against them.

Cumberland has met three of the Big Four, won one, lost one, tied one. Vanderbilt and Sewanee have met each only two of the Big Four, lost one and won one each. Clemson met only one of the Big Four, resulting in a tie. These are the facts as to Cumberland's record, and as to the championship she is more than willing to leave the public to decide.

All of Cumberland's team, with the possible exception of one or two, will return next year. Most teams have a few star players. In this respect Cumberland's team has been unusual; they were all star players. If there are any two more worthy than the others of a place on the All-Southern Team, they are Suddarth and Smith.

The good work of Coach Phillips needs no commendation. Results speak more eloquently than words. He will coach the team again next year, and he will have the help of a first-class assistant coach. Cumberland will have two teams next year, and will play two full schedules. Not only will all her old team, with the possible exception of one or two, return, but she will have several new men whose past work indicates that they will be among her best players for next season. This is her first serious attempt at football, but she expects to figure prominently in athletics in the future.

BASKET BALL.

Cumberland expects to have one of the best basket ball teams for 1903-04 in the South. Her team for 1902-03 was an ordinary team with two or three very fine players on it. During the season they lost and won about the same number of games. All the old team, with one or two exceptions, are back, and, with three of Mooney's last year's crack players and some other very fine new material, Cumberland is certain to put out one of the very best teams of the South.

BASEBALL.

In baseball also Cumberland expects to have a winning team. Never were her prospects so bright. Cumberland's team for last year was a fairly good one, winning and losing about the same number of games. A few of her players were very fine. All the old team have returned, and will try for their old places. Added to this is an unusually large number of new men of very fine ability and record who will try for places on the team. A first-class coach will train the team.

TRACK TEAM.

Cumberland University has never attempted to put out a track team; but this year she has an unusually fine lot of material for such a team, and she will appear for the first

time as contestant for honors in this line. Cumberland's enlarged student body makes it possible for her to have not only a full line of athletic teams, but to place in the field teams equal to the very best.

MORAL TONE.

The moral and religious tone of Lebanon is unsurpassed. The various denominations are represented with good Churches. Saloons, with their attendant evils, have been banished forever from the town. The faculty of the University is genuinely religious. The College Y. M. C. A. uses every means to lead the unsaved to Christ. At the close of last year's work only two students in the College were unsaved. The temptations to students in such a town and University are very small compared with those found in the city. Parents who wish to send their boys where the dangers of college life are the least should not fail to consider this point with care.

LYCEUM.

For years past Lebanon and the University students have been dependent upon the Literary Societies of the University for all their entertainments and lyceum courses. Our societies have done themselves credit in the efforts which they have made, but the lyceum courses have not been all that could be desired. Appreciating fully the educational and other advantages of the highest grade lyceum course, the University authorities have taken the matter in hand, and for this year have arranged a course of ten entertainments to be given by some of the best talent on the American platform. The town and University have shown their appreciation by a patronage which has already insured the permanent success of the enterprise, and it has been decided to make the University Lyceum Course an annual affair.

THE NEW CHAPEL.

A special train from Nashville to Lebanon last May brought the entire General Assembly of the Cumberland Presbyterian Church to Lebanon, to the dedication of the new chapel in Memorial Hall. The work was at that time not complete; it had only been prepared for the artist. The work has now been finished, and, while not the largest, it is perhaps the most elaborately finished chapel in the South. The entire chapel is frescoed on canvas. In the very large and beautiful center panel overhead has been placed four educational emblems: On the north two cherubs hold the earth, representing geology and natural science; on the east two cherubs hold the retort and balance, representing chemistry and physics; on the south two cherubs hold the telescope and gyroscope, representing astronomy and mathematics; while on the west two cherubs hold the Bible and cross, representing religion. The walls are a dark red, and, when lighted, are very beautiful. The pilasters are Mexican onyx, with cap and base of antique copper bronze. The wainscoting is Italian-Sienna marble, with black baseboard. In the coves on either side and over each of the ten windows will be placed the pictures of ten distinguished Cumberland Presbyterians. Four of these spaces will be reserved for the future, the remaining six will be filled at once. Pictures to be used at present are those of Drs. S. C. Cossitt, T. B. Anderson, and W. B. McDonald, former presidents of the University. The pictures of Robert L. Caruthers, founder of the University and president of its board of trustees till his death, of Richard Beard, D.D., the first professor of theology in the Theological Seminary, and that of Rev. Finis Ewing, one of the founders of the Cumberland Presbyterian Church, will be used. The other founders of the Cumberland Presbyterian Church left no pictures. It is the policy of the institution to use the pictures of no living men.

The chapel is lighted with a very large chandelier of thirty-six lights and two hundred additional incandescents. Seated with chairs, it will accommodate an audience of seven hundred people.

While each department of the University has its own daily chapel services, all departments come together in the new chapel every Friday for devotional services. This brings all departments together and furnishes a splendid opportunity for a wide range of association and cultivation, which has been hitherto impossible.

ALUMNI NOTES.*

'50—Col. John F. House, Clarksville, Tenn., late Member of Congress, has been elected by the Southwestern Presbyterian University at Clarksville as Dean of the new Law Department which it has recently established.

'52—Gen. William B. Bate, United States Senator from Tennessee since 1887, is a candidate for reelection. He has agreed to visit the University soon and deliver a lecture to the Faculty and student body.

'57—R. R. Gaines, Austin, Tex., was Judge of the Sixth Judicial District, Texas, 1881-85; Associate Justice Supreme Court 1885-94; Chief Justice since 1894.

'58—Hon. N. N. Cox, of Franklin, Tenn., has for a few years enjoyed the quiet of private life. Madam Rumor is responsible for the report that he may be a candidate for Congress again.

'58—E. S. Hammond, Memphis, Tenn., was appointed United States District Judge June 17, 1878, which position he still holds.

'59—Ex-Gov. James B. McCreary, of Richmond, Ky.,

* Contributions to this department of the Bulletin will be appreciated very much. No department is appreciated more by our readers, and contributions are earnestly solicited. Address Rev. P. Marion Simms, Registrar.

who served in the Fiftieth, Fifty-First, Fifty-Second, Fifty-Third, and Fifty-Fourth Congresses, and who was elected to the United States Senate in 1902, was one of the most prominent Democratic campaign orators in Kentucky this past fall.

'59—W. D. Beard, Memphis, Tenn., is Chief Justice of the Supreme Court of Tennessee.

'59—Col. R. T. Bennett, Wadesboro, N. C., ex-Supreme Judge and ex-Congressman from North Carolina, will deliver the address to the law class, June, 1904.

'59—H. M. Somerville, of 265 Central Park, West New York, who was founder of the Law School in the University of Alabama, 1873, Supreme Judge of Alabama 1880-90, has been Chairman of the National Board of Customs Appraisers since 1890.

'61—Col. J. D. Tillman, of Fayetteville, Tenn., who was appointed by President Cleveland as Minister to Ecuador, has spent the past five years on his farm.

'61—William Young Pemberton, who was Chief Justice of the Montana Supreme Court 1872-78, is now practicing law at Butte, Mont.

'67—Judge Horace H. Lurton, Nashville, Tenn., is Lecturer in Law in the University of the South. He is also Professor and Lecturer in Law in Vanderbilt University. From Chancellor he rose to Associate Justice of the Supreme Court of Tennessee, of which he became Chief Justice in 1893. He was then appointed by President Cleveland United States Circuit Judge of the Circuit Court of Appeals for the Sixth Judicial Court, which position he still holds.

'68—A. C. Stewart, of St. Louis, Mo., has just returned from Europe. He is the son of Gen. A. P. Stewart, who for many years taught mathematics in Cumberland University. Mr. Stewart is attorney of the St. Louis Union Trust Company, a nine-million-dollar trust company.

'68—R. L. C. White, of Nashville, Tenn., was appointed Supreme Keeper of Records and Seal of the Knights of Pythias in 1887, and has been elected continuously since.

'69—Ex-Gov. Murphey J. Foster, Franklin, La., present United States Senator, is a candidate for reelection. Mr. Foster, some years ago, led and won the fight against the Louisiana State Lottery in his State Legislature.

'70—M. E. Benton, Neosho, Mo., was elected to the Fifty-Fifth Congress and reelected to the Fifty-Sixth, Fifty-Seventh, and Fifty-Eighth Congresses.

'70—David D. Shelby, New Orleans, La., was appointed Circuit Judge of the Fifth United States Circuit Court of Appeals, which appointment was confirmed by the United States Senate March 3, 1899. Recently he visited his *Alma Mater* and addressed the law students.

'71—W. R. L. Smith, of Richmond, Va., was pastor of the First Baptist Church, Lynchburg, Va., 1878-90; three years pastor of the First Baptist Church, Nashville, Tenn.; three years pastor of the Third Baptist Church, St. Louis, Mo.; and in 1897 was called to the Second Baptist Church of Richmond, Va., where he has served since. He is now a trustee of three colleges of Richmond, Va., and of the Baptist Theological Seminary, Louisville, Ky.

'72—Thomas N. McClelland, Montgomery, Ala., was Associate Justice of the Supreme Court of Alabama 1889-98. Since 1898 he has served as Chief Justice.

'72—J. W. Bonner, Nashville, Tenn., is a member of the Law Faculty of Vanderbilt University.

'73—B. A. Enloe, Jackson, Tenn., has been elected Secretary and Director of the State World's Fair Commission.

'75—William F. Herrin, San Francisco, Cal., entered the railway service in 1893 as Chief Counsel of the Pacific System, Southern Pacific Company, which position he still holds at a salary of \$50,000 per annum.

'76—Thetus W. Simms, Linden, Tenn., was Presidential Elector on the Democratic ticket in 1892. He was elected to the Fifty-Fifth Congress, and reëlected to the Fifty-Sixth, Fifty-Seventh, and Fifty-Eighth Congresses. In the Fifty-Sixth Congress he was appointed to the Committee on the District of Columbia, to succeed Hon. James D. Richardson, and was also appointed to the Committee on War Claims, which position he has ever since retained, being ranking member of the minority on the Committee on War Claims and third on District of Columbia.

'78—W. B. Swaney, Chattanooga, Tenn., was President of the Tennessee Bar Association during 1896 and 1897. He is a member of the faculty of Grant University.

'80—C. K. Wheeler, of Paducah, Ky., ex-Congressman, is now enjoying a lucrative practice of his profession with the firm of Wheeler, Hughes & Berry.

'81—Theodore Brantly, Helena, Mont., was Judge of the Third District of Montana 1892-98, and in 1898 was elected Chief Justice of the State for six years.

'83—Joseph W. Bailey, Gainesville, Tex., was Presidential Elector of Mississippi, his native State, in 1884; was Presidential Elector in Texas for the State at large in 1888; a Member of Congress, 1891-01; United States Senator, 1901-07.

'85—F. G. Bridges, since his graduation, has been a prominent corporation lawyer of Pine Bluff, Ark. He is President of the Pine Bluff Light and Water Company, and has been Mayor of the city.

'85—John Lunsford Robinson has been pastor of the Unitarian Church of Brooklyn, Conn., since 1899.

'85—J. W. Handley, Nashville, Tenn., has been a professor in the University of Tennessee since 1888. He occupies the chair of Genito-Urinary Surgery. In April, 1891, the Medical Department of the University of the South was organized with Dr. Handley as Professor of

Genito-Urinary and Venereal Diseases, which position he still holds.

'85—J. S. Buchanan has been Professor of History in Oklahoma University since 1895.

'85—William H. Clark, of Dallas, Tex., during 1897 and 1898 was President of the Bar of Texas, the youngest President in the history of the Association.

'87—R. M. Milburn, Bloomington, Ind., present State Senator from his district, is Associate Professor of Law in Indiana University.

'88—R. E. L. Johnson, of Paragould, Ark., recently Acting Chief Justice of the Arkansas Supreme Court, handed down some decisions which elicited very favorable comment from the State press.

'88—Ira Landrith, LL.D., for thirteen years editor of the *Cumberland Presbyterian*, has just been elected to the office of General Secretary of the Religious Education Association, with headquarters at Chicago.

'88—S. Arakawa, Osaka, Japan, is President of the Osaka Marine Court and Superintendent of the Osaka Marine Office. He is also a professor in the Imperial Navigation College of Tokyo.

'90—W. S. McClain occupies the chair of Histology and Medical Jurisprudence in the Southern School of Osteopathy, Franklin, Ky.

'90—Henry A. Lindsley, of Denver, Colo., who is District Attorney for the Second Judicial District of Colorado, City and County Attorney for Denver, spent about two weeks with his mother, Mrs. J. I. D. Hinds, of Lebanon, during the month of October.

'92—G. A. Miller, Stanford University, Cal., has been Assistant and Associate Professor of Mathematics in Stanford University since 1901. In 1901 he won an international mathematical prize.

'93—Dr. W. A. Bryan, Nashville, Tenn., for some years

Demonstrator and Assistant to the Chair of Surgery in Vanderbilt University, has been made Adjunct Professor of Surgery. He is also Lecturer on General and Oral Surgery in the Dental Department of Vanderbilt and Surgeon to the St. Thomas Hospital.

'95—W. P. Darwin is now in the government service at Washington, D. C., as Assistant Engineer in the Supervising Architect's office. Since August 1 he has had entire charge of the engineering features of four government buildings.

'98—Miss Helen Buquo, of Chattanooga, is at present in the Art Academy of Cincinnati, Ohio, where she has already finished two years of work.

'98—Paul Yates, 378 Wabash Avenue, Chicago, is Assistant Manager of the Albert Teachers' Agency of that city.

'01—E. D. Kuykendall, coach of the Cumberland football team of 1900 and manager of baseball team in 1901, has formed a partnership in law with his brother at Greensboro, N. C.

Of the twenty-two living ex-Moderators of the General Assembly of the Cumberland Presbyterian Church, fourteen are Cumberland University men, and also eleven of the twenty home missionaries in the employ of the Board of Missions of the Cumberland Presbyterian Church.

The Board of Missions of the Cumberland Presbyterian Church has sent as missionaries to the foreign field since 1901: H. L. Latham, B.D. '01, and W. F. Hereford, A.B. '99, B.D. '02, to Japan; I. G. Boydston, A.B. and B.D. '03, and G. F. Jenkins, B.D. '03, to China.

The Committee on Fraternity and Union, appointed by the General Assembly of the Cumberland Presbyterian Church at its last meeting for the purpose of conference with a similar committee from other Presbyterian

Churches with a view to organic union, has among its membership eight Cumberland University men.

At the last June commencement J. I. D. Hinds, A.B. and A.M. '73, Professor of Chemistry in the University of Nashville, J. L. Goodnight, A.B. '71, Dean Lincoln College of Millikin University, and Ira Landrith, B.S. '88, LL.B. '89, editor of the *Cumberland Presbyterian*, were honored with the degree of LL.D.

According to the Congressional Directory, the Fifty-Eighth Congress of the United States, extraordinary session, had more men from Cumberland University than from any other Southern institution except the University of Virginia. Only four Northern institutions—namely, Yale, Harvard, Columbia, and the University of Michigan—had a larger representation. In the Fifty-Eighth Senate of the United States Cumberland tied Yale in graduate representatives, while Yale had a few others who had taken parts of courses. The University of Virginia could tie Cumberland by counting one man who did not graduate. Cumberland leads all others in the number of Senators.

A few months ago Rev. P. Marion Simms, Registrar, began to locate the graduates of the University, hoping to place on file in the University a short sketch of the life of every man who ever graduated in any department of the institution. Already many such sketches of both dead and living have been obtained. The present addresses of about eighteen hundred of the nearly three thousand and five hundred graduates of the University have been obtained. Among the alumni who have been located have been found forty-five Congressmen, four present United States Senators, twenty-six Judges State Supreme Courts, eight Governors of States, eight Confederate Generals, and twenty-five College Presidents.

Many of the leading colleges and universities of the land have in their faculty Cumberland University men. The following are a few of the institutions in whose faculties are found some of Cumberland's men: University of Nashville, the Chancellor and two members of the faculty; Trinity University, Texas, the President and three members of the faculty; Arkansas Cumberland College, the President; Missouri Valley College, Missouri, the President and three members of the faculty; Vanderbilt University, three members of the faculty and one a professor in two departments; University of the South, Sewanee, two members of the faculty; Columbia University, New York City, two members of the faculty; Leland Stanford, Jr., University, one member of the faculty; University of Tennessee, one member of the faculty; University of Indiana, one; Oklahoma University, one; Grant University, Chattanooga, one; Millikin University, four; Cumberland University, the President and eighteen members of the faculty. What honors may be found among the fifteen hundred and more alumni concerning whom the University knows nothing cannot even be guessed. As soon as a sketch of every alumnus, or as nearly every one as practicable, has been obtained, a number of the University *Bulletin* will be issued in which will be given every alumni of the institution, with the principal facts of each life. Will every graduate who reads these lines (who has not already done so) send us the information concerning himself asked elsewhere in this issue?

The University has no complete file of her catalogues. The following years are wanting: '44-'45, '45-'46, '49-'50, '67-'68. Will not some alumni or friend supply the missing numbers? The University desires also to place on file any old papers published by students or faculty, any speeches or addresses by faculty or alumni on occasions of

importance to the University, or any other papers of historic or other interest to the University. Such contributions will be appreciated very much.

FACULTY NOTES.

L. L. RICE, Ph.D., Professor of English Language and Literature, was a member of the faculty of Peabody Normal Summer School at Nashville, Tenn., last summer.

Robert W. Keeton, A.B., Assistant in Biology, spent the summer in Chicago University. He is spending the winter in Millikin University, Decatur, Ill.

James S. Waterhouse, A.M., Professor of Chemistry and Natural Science, spent the summer in Chicago University. On November 25, 1903, Mr. Waterhouse was married to Miss Katharine White, of Lebanon, Tenn.

President D. E. Mitchell was engaged as one of the lecturers at Northfield during last summer, but on account of pressing business matters was compelled to cancel the engagement.

Prof. F. J. Stowe, O.M., Dean of the School of Oratory and Professor of History, was during the summer Professor of Oratory in the Summer School of Brenau College, Gainesville, Ga. He met with the Southern Elocution Association which convened in Atlanta, Ga., December 26-28, where he delivered an address on "The Personality of the Orator." He was elected President of the Association.

Rev. J. R. Henry, Dean of the Theological Department, was one of the lecturers at the Texas Cumberland Presbyterian Chautauqua, held for nine days at Waxahachie, Tex., beginning August 21, 1903. The last General Assembly of the Cumberland Presbyterian Church

made Mr. Henry a member of the Church's Board of Education, and at a recent meeting of the Board he was elected President of the Educational Society.

The fourth edition of "The History of a Lawsuit" was issued some weeks since from the press of Robert E. Clark Company, of Cincinnati, O. This edition is the second revision by Andrew B. Martin, LL.D., Professor of Law in Cumberland University, of this celebrated book. The profession at large will be glad to know that a new edition is now ready.

The many friends of Rev. Dr. and Mrs. C. H. Bell tendered them a reception December 1, in the parlors of the new University dormitory, on the occasion of the forty-fifth anniversary of their wedding. It was a complete surprise to those in whose honor it was given, who were decoyed to the scene of the reception on different pretexts after the guests had assembled. Interesting features were the presentation to Mrs. Bell of a bunch of chrysanthemums grown from a cutting from the parent plant which furnished flowers for the wedding forty-five years ago, an original poem by ex-Chancellor Green of the University, and a testimonial in gold coin from friends by Dr. A. B. Martin. Dr. Bell has for many years occupied the chair of Missions and Apologetics in the University, and both he and his accomplished wife have long been prominent in the mission work of the Church.

A. H. Buchanan, LL.D., Dean of the College Faculty and Professor of Mathematics in Cumberland University, was appointed by the United States Supreme Court in 1900 Commissioner from Tennessee "to ascertain, retrace, re-mark, and reestablish the boundary line established between the States of Tennessee and Virginia by the compact of 1803." Virginia was represented by Dr. James B. Baylor, assistant in the United States Coast Survey

Service; and the third man, Mr. W. C. Hodgkins, assistant in the United States Survey Service, was taken from Massachusetts. Two summers were spent in the work. The entire boundary between Tennessee and Virginia was surveyed and marked by ninety-nine stone monuments in addition to numerous markings on trees along the line. The report of the Commissioners was unexcepted to by either State, and, on motion of the Attorneys-General for the two States, was in all things confirmed by the United States Supreme Court. Printed copies of the decree of the Supreme Court of the United States, as announced by Chief Justice Fuller, were distributed in June, 1903. Prof. Buchanan's connection with the coast and geodetic survey for twenty years gave him preëminent qualifications for the position and made his services in the work invaluable.

INFORMATION DESIRED FROM ALUMNI.

Every alumnus of any department of Cumberland University who sees this is requested (if he has not already done so) to mail to Rev. P. Marion Simms, Registrar, at once, the information suggested below, to be placed on permanent file in the University's office and to be used later in a catalogue of the University which will attempt to give some information concerning every graduate of the institution:

Name.....
Date of Birth.....
Present Address.....
Honorary Titles.....
Occupation.....
Brief biography since leaving the University.

Let biography contain schools educated in, degrees taken and their dates, Church relations, memberships in secret societies, official positions held now or formerly, honors won, etc. To this add any fact of importance which the above does not include.

Use the above as a suggestion, please, and write with pen or typewriter and on paper letter size. The courtesy will be greatly appreciated by the University.

If you can assist us in getting information concerning any of your classmates or other alumni, living or dead, it will be appreciated.

UNIVERSITY OF ILLINOIS-URBANA



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